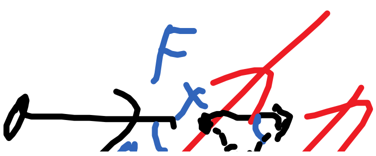
Thursday, March 01, 2018 12:26 PM

Mass Spectroscopy

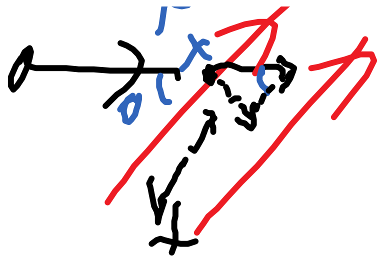
From last class
charged particles moving perpendicular to a magnetic field move in a circular tragectory
Fc=Fb
$mv^2/r = qvB$
$r = mv/(qB)$

What if the particle hits the field at an angle?

$Fb = qvB\sin\theta$
for our example
$1.602\times10^{-19}\,C\times(0.80\times3.0\times10^{8}\,m/s)(5\times10^{-4}T)\sin(35^{o})$
$1.602\times0.8\times3\times5\times Sin(35)=$
11.02643341241251
1.1×10^{-14} N ← into the page on the diagram

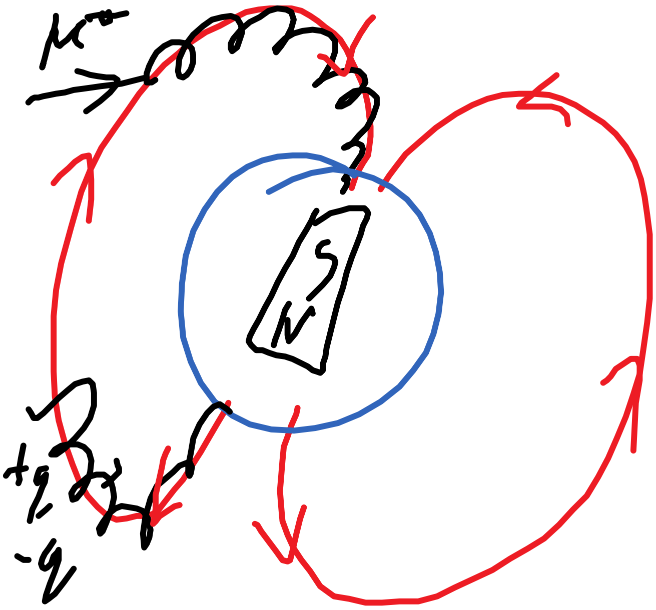


– move in a



– move in a spiral path, with radius

$$r = \frac{mv}{qB\sin\theta}$$



So the charged particles from cosmic rays follow the magnetic field lines to the poles and hit the atmosphere at high speeds. When charged particles change energy states, they emit photons E=hf. - pretty colours

(pun for Aurora borealis - Northern lights)

Mass Spectroscopy and Milliken

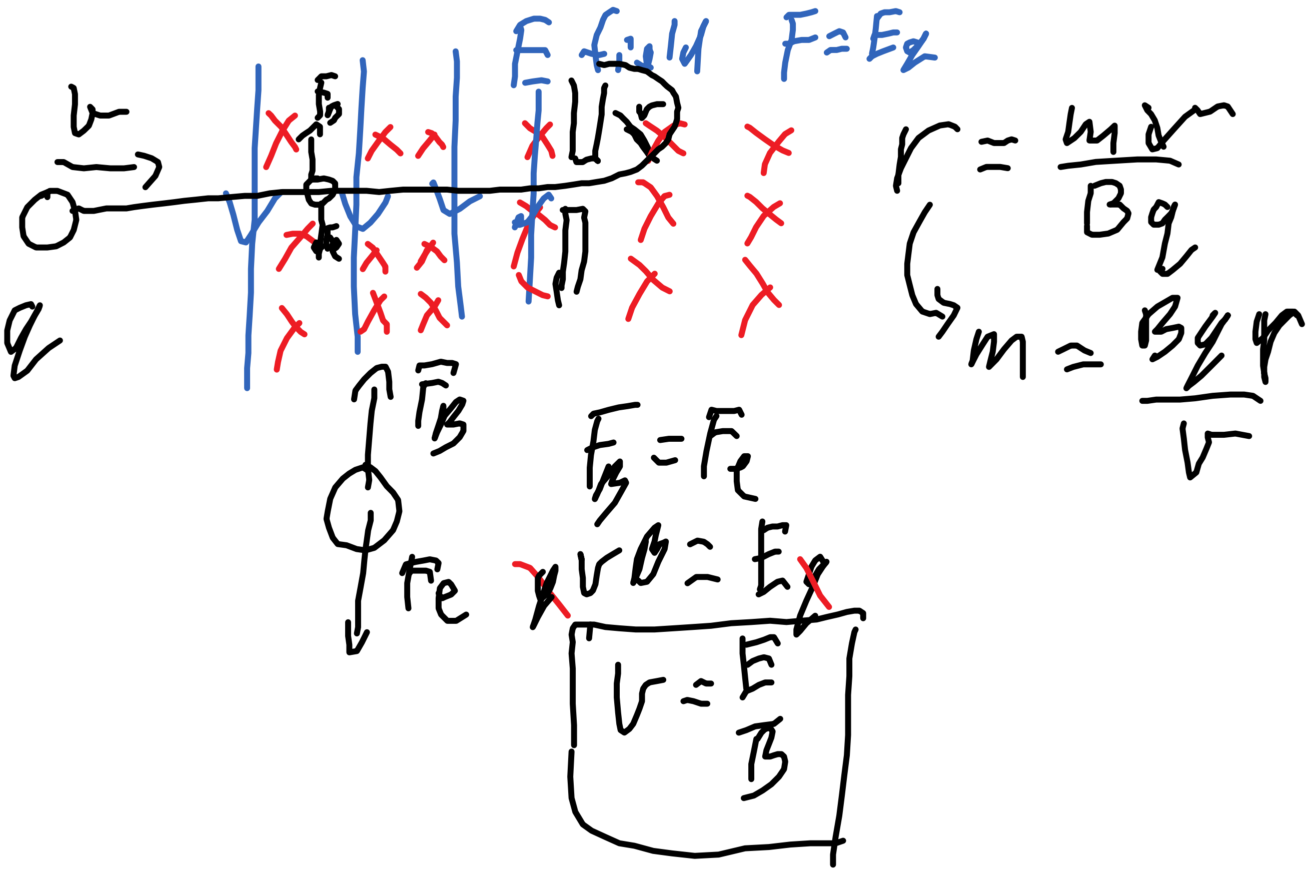
Milliken Oil drop experiment - Determine the charge of electrons.
eg. you spray oil droplets between parallel plates, 6.0 mm apart and they levitate with a single excess electron in the oil. What voltage is between the plates?

oil density: 874 kg/m^3 radius of 0.7 µm = 0.7x10-6 m. 

$F_e = F_g = mg$

once you know the charge of a particle, you can determine the mass using

crossed electric and magnetic fields as a velocity selector and then the radius of the path in a magnetic field (or period of revolution) to determine the mass/charge ration and therefore the mass.



a unknown particle with charge 2e+ moves at 5.0 x 10^6 m/s perpendicular to a 0.15T magnetic field.

a) what is the magnetic force on the particle? F =

b) what strength electric field will balance the magnetic force?

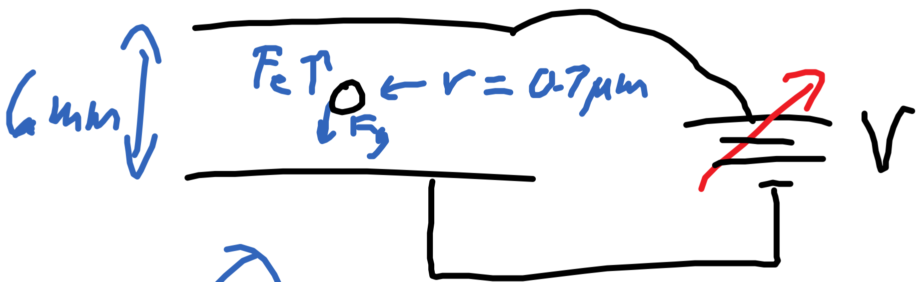
c) if the radius of the path after

leaving the electric field but maintaining the magnetic field is 3.00 cm, what is the mass of the particle?

$V = 4/3\ \pi\ r^3$

$\rho = m/V$

$m = \rho\ 4/3\ \pi\ r^3$



$$Eq = mg$$

$$E = \frac{V}{d}$$

$$V = \frac{mgd}{q}$$

$\rho\ 4/3\ \pi\ r^3\ x g\ x d/q$

$874\ kg/m^3\ x 4/3\ \pi\ (7x10^{-7} m)^3\ x$

$9.81 N/kg\ x\ 6x10^{-3}\ m\ /1.602x10^{-19} C$

874x(4/3)

x3.14159x7x7x7x9.81x6/1.602=
4.61372E7
461V

a unknown particle with charge 2e+ moves at 5.0 x 10^6 m/s perpendicular to a 0.15T magnetic field.
F = qvB = 2x1.602E-19x5E6x0.15=
0.0 = 2.4x10^{-13}N

b) v=E/B so E=Bv = 0.15x5E6=
750,000.0 = 7.5x10^5N/C
c) m = Bqr/v = 0.15x2x1.6x0.03/5=
0.0029
m = 2.9 x 10^{-28} kg

lab p93, pre-read bring labbook Monday
test Friday circuits and magnetic force